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European Academy of Neurology and European Stroke Organization consensus statement and practical guidance for pre-hospital management of stroke

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Background and purpose: The reduction of delay between onset and hospital arrival and adequate pre-hospital care of persons with acute stroke are important for improving the chances of a favourable outcome. The objective is to recommend evidence-based practices for the management of patients with suspected stroke in the pre-hospital setting.

Methods: The GRADE (Grading of Recommendations Assessment, Development and Evaluation) methodology was used to define the key clinical questions. An expert panel then reviewed the literature, established the quality of the evidence, and made recommendations.

Results: Despite very low quality of evidence educational campaigns to increase the awareness of immediately calling emergency medical services are strongly recommended. Moderate quality evidence was found to support strong recommendations for the training of emergency medical personnel in recognizing the symptoms of a stroke and in implementation of a pre-hospital 'code stroke' including highest priority dispatch, pre-hospital notification and rapid transfer to the closest 'stroke-ready' centre. Insufficient evidence was found to recommend a pre-hospital stroke scale to predict large vessel occlusion. Despite the very low quality of evidence, restoring normoxia in patients with hypoxia is recommended, and blood pressure lowering drugs and treating hyperglycaemia with insulin should be avoided. There is insufficient evidence to recommend the routine use of mobile stroke units delivering intravenous thrombolysis at the scene. Because only feasibility studies have been reported, no recommendations can be provided for pre-hospital telemedicine during ambulance transport.

Conclusions: These guidelines inform on the contemporary approach to patients with suspected stroke in the pre-hospital setting. Further studies, preferably randomized controlled trials, are required to examine the impact of particular interventions on quality parameters and outcome.

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Introduction

Stroke is a leading cause of disability in adults and a major cause of death. Specific therapies for acute stroke are most effective when initiated soon after symptom onset. This requires rapid clinical assessment and brain imaging.

Intravenous thrombolysis with recombinant tissue plasminogen activator is effective in acute ischaemic stroke up to 4.5 h after symptom onset, and recent trials have shown significant additional benefits of thrombectomy in patients with large vessel occlusion [1,2]. As time is critical for improving outcome, appropriate pre-hospital assessment and management of persons suspected of acute stroke are important for reducing delays for revascularization therapies, and in the meantime limiting secondary brain damage during transport.

The purpose of this clinical guideline is to develop recommendations for the management of persons with suspected acute stroke from the scene to the hospital.

Methodology

A working group consisting of experts in acute stroke medicine and neurology, an expert on guideline methodology and a representative of the European patient organization Stroke Alliance for Europe was proposed by the Stroke Scientist Panel of the former European Federation of Neurological Sciences (EFNS), the European Stroke Organization Guidelines Committee and the Subcommittee for Cerebrovascular Diseases of the former European Neurological Society.

The guideline was developed in concordance with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology [3]. The work of this task force was set up during a stage when the recent standard operating procedures for writing guideline documents of the European Stroke Organization and European Academy of Neurology (EAN) were not yet effective [4,5].

During a first meeting, the members of the working group established a consensus on 14 specific PICO (patient, intervention, comparator, outcome) questions. For each PICO question two members were assigned to perform a literature search using relevant MeSH terms. A search of MEDLINE, Embase and the Cochrane Library was performed up to March 2016. Language restrictions were not applied. Conference reports and case reports were excluded.

All selected articles were cross-referenced to make certain that no relevant studies were excluded. References cited in the selected articles were checked for further relevant articles not identified by the electronic searches. Two reviewers read all identified papers and disagreements were resolved through discussion. When a recent systematic review was available to answer a PICO question, only the literature after publication of the systematic review was further assessed. During a second meeting of the working group, the quality of evidence was derived, and strength of recommendation was decided by consensus. Quality of evidence was graded as high, moderate, low or very low [3]. A summary of findings table to obtain an overall effect estimate is only presented when homogeneous randomized controlled trials (RCTs) were available. For a number of PICO questions, an 'additional information' section is added just after the recommendation section.

Results

The recommendations for each PICO question are summarized.

Rapid recognition of stroke

PICO 1. In people with suspected acute stroke, do educational interventions aimed at the general public increase the likelihood of the emergency medical services (EMS) being called immediately?

Randomized controlled trials investigating the effect of educational interventions on the interval between onset of symptoms and EMS call were not found. A related but indirect outcome, reduction in pre-hospital delay, was recently assessed in a systematic review [6], including 13 studies. Only one, the Berlin Acute Stroke Study, was a cluster RCT [7]. The educational intervention consisted of a letter indicating stroke symptoms and emphasizing the need to call EMS immediately, accompanied by a sticker with main stroke symptoms and the telephone number of the EMS. A total of 75 720 households received the intervention. The intervention was found to be effective in reducing pre-hospital delays in women but not in men. However, the study had several limitations, including a limited precision of time assessments. The other studies were before and after studies or observational studies. Ten studies reported a statistically significant reduction in pre-hospital delay following the educational intervention. Heterogeneity and methodological weaknesses limit a proper meta-analysis and generalizability of the observed effects. The working group decided to give a strong recommendation despite the very low quality of evidence, because the possible benefit of early recognition of stroke symptoms by the general population and of immediate EMS call clearly outweighs any possible harm. Sustained campaigns should remain the cornerstone to educate the general population in recognizing stroke symptoms and the need to call EMS immediately (Table 1).

Recommendation
Educational campaigns are recommended to increase the awareness of immediately calling EMS for people with suspected stroke.

(strong; very low quality of evidence)

PICO 2. For EMS technicians and paramedics, are simple pre-hospital stroke scales useful to identify potential stroke patients?
A recent systematic review was identified examining the accuracy of recognizing pre-hospital stroke patients using the QUADAS-2 tool. The following simple stroke scales were included: the Face Arm Speech Test (FAST), Cincinnati Pre-hospital Stroke Scale (CPSS), Los Angeles Pre-hospital Stroke Screen (LAPSS), Melbourne Ambulance Stroke Screen (MASS), Medic Pre-hospital Assessment for Code Stroke (Med PACS), Ontario Pre-hospital Stroke Screening Tool (OPSS) and Recognition of Stroke in the Emergency Room (ROSIER) [6]. All of the above studies were observational studies and excluded those in which physicians were involved in pre-hospital application of the stroke scale. Pre-hospital stroke scales varied in their accuracy and globally missed up to 30% of acute strokes in the field. All stroke scales had a high sensitivity, ranging from 74%–97%. Specificity of the comparable FAST (13%) and CPSS (24%–79%) was lower than scales including more items, such as LAPSS (85%–97%), MASS (74%–86%) and OPPS (86%), with the exception of Med PACS (33%) and ROSIER (18%). Despite the low quality of evidence a strong recommendation is issued because the possible benefit of identifying potential stroke victims clearly outweighs any possible harm and the associated resource use is minimal.

Recommendation
It is recommended that all EMS technicians and paramedics are familiar with a simple pre-hospital stroke scale to identify potential stroke patients. No specific scale can be recommended.

(strong; low quality of evidence)

Additional information
Current simple pre-hospital stroke scales are not sensitive for detecting posterior circulation stroke.

Table 1 Summary of recommendations

PICO	Recommendation	Quality of evidence	Strength of recommendation
1	Educational campaigns to increase the awareness of immediately calling EMS for people with suspected stroke are recommended	Very low	Strong
2	It is recommended that all EMS technicians and paramedics are familiar with a simple pre-hospital stroke scale to identify potential stroke patients. No specific scale can be recommended	Low	Strong
3	There is insufficient evidence to recommend a pre-hospital stroke scale to predict large vessel occlusion		
4	In patients with SaO_2 levels <95% the administration of O_2 titrated to maintain normoxia is recommended. Routine use of O_2 is not recommended	Very low	Weak
5	Pre-hospital treatment of high blood pressure in people suspected of acute stroke is not recommended	Very low	Weak
6	Because of safety concerns pre-hospital administration of insulin in persons with suspected stroke and hyperglycaemia is not recommended	Very low	Weak
7	In the absence of clinical studies no recommendations can be made on pre-hospital interventions for lowering elevated body temperature		
8	It is recommended that all EMS implement a 'code stroke' protocol, including highest priority dispatch, pre-hospital notification and rapid transfer to the closest 'stroke-ready' centre	Moderate	Strong
9	No recommendation on the additional value of pre-hospital telemedicine can be made		
10	The routine use of mobile emergency stroke units is not recommended because there is insufficient evidence that they lead to a better functional outcome	Low	Weak
11	No recommendation can be made on the pre-hospital use of POC laboratory analysis of blood count and INR		
12	No recommendation can be made on the use of currently available biomarkers in persons with a suspected stroke		
13	Air medical transport is not suggested outside of settings where a pragmatic decision has been taken that geographical conditions favour air transport	Weak	Very low
14	The use of any neuroprotective intervention is not recommended	High	Strong

PICO 3. For EMS technicians and paramedics, are pre-hospital stroke scales useful for predicting large vessel occlusion?

A retrospective analysis of two databases including 119 patients reported that a hospital score ≥4 on the Los Angeles Motor Scale predicted the presence of large artery anterior circulation occlusion with high sensitivity (81%) and specificity (89%) [7]. However, this has not been prospectively validated. The Rapid Arterial Occlusion Evaluation (RACE) scale was validated prospectively in the pre-hospital setting by trained EMS technicians for 357 consecutive patients in a single comprehensive stroke centre study. Large vessel occlusion was diagnosed by transcranial duplex, computed tomography (CT) angiography or magnetic resonance angiography. A RACE scale score ≥5 had a sensitivity of 85%, specificity of 68%, positive predictive value of 42% and negative predictive value of 94% for detecting large artery anterior circulation occlusion [8]. There is insufficient evidence that these stroke scales could be useful instruments for selecting stroke patients for direct transport to comprehensive stroke centres.

Recommendation

There is insufficient evidence to recommend a pre-hospital stroke scale to predict large vessel occlusion.

Rapid stabilization of vital parameters

PICO 4. In people with suspected acute stroke who are hypoxic, does pre-hospital O_2 administration compared to no O_2 administration improve outcome?

Studies investigating in-hospital routine O_2 therapy started <24 h after stroke onset (2 or 3 l/min for 24–72 h), although showing slight improvement in neurological status 7 days after stroke onset, failed to show a benefit in terms of long-term survival and independence [9–11]. No RCT has compared O_2 administration versus no O_2 administration in persons suspected of acute stroke in the pre-hospital setting. Hypoxia should be avoided because it may amplify ischaemic brain damage and worsen outcome [12]. Although there are no supportive RCTs, the working group decided to follow the guidelines published by the British Thoracic Society advocating titrated O_2 therapy [13].

Recommendation

In patients with SaO_2 levels <95% the administration of O_2 titrated to maintain normoxia is suggested. Routine use of O_2 is not recommended.

(weak; very low quality of evidence)

PICO 5. In people with suspected acute stroke, does pre-hospital high blood pressure reduction compared to no intervention on blood pressure improve outcome?

Both hypertension and marked hypotension are associated with poor outcome after stroke [14], and there is considerable clinical uncertainty as to the optimal management of blood pressure acutely after stroke. There are two small single centre feasibility RCTs in pre-hospital acute stroke patients who were hypertensive (systolic blood pressure ≥140 mmHg or >160 mmHg) assessing the safety and outcome of antihypertensive therapy. The Rapid Intervention with Glyceryl Trinitrate in Hypertensive Stroke Trial and the Paramedic Initiated Lisinopril for Acute Stroke Treatment Trial showed that it was feasible to perform an ambulance-based paramedic-delivered trial of blood pressure lowering in patients with acute stroke (<4 h of stroke onset) [15,16]. Both trials selected the immediate blood pressure lowering effect as the primary outcome. Due to the small size of the studies (55 patients recruited in total) no conclusions on safety, efficacy and outcome could be drawn from this study. Even for systolic blood pressure ≥185 mmHg, which may prolong door to needle time, urgent pre-hospital antihypertensive treatment by paramedics holds a risk for sudden drops of the blood pressure; therefore treatment of high blood pressure in the pre-hospital phase should be avoided.

Recommendation

Pre-hospital treatment of high blood pressure in people suspected of acute stroke is not recommended.

(weak; very low quality of evidence)

PICO 6. In people with suspected acute stroke, does pre-hospital treatment of hyperglycaemia with insulin compared to no treatment improve outcome?

Blood glucose should be measured in every patient with suspected stroke because symptoms of hypoglycaemia can mimic those of a stroke. Hypoglycaemia (<60 mg/dl or <3.3 mmol/l) needs to be treated with glucose 20%–40% in 25–50 ml infusion [17].

People with hyperglycaemia concomitant with large vessel acute ischaemic stroke have greater mortality, stroke severity and functional impairment compared with those with normoglycaemia. However, this has not been found in patients with a lacunar stroke [18,19]. Only one small feasibility study dealing with lowering glucose in acute stroke patients in the pre-hospital setting was identified [20]. In this study, patients with stroke symptoms and plasma glucose >108 mg/dl or 6.0 mmol/l were randomized during the pre-hospital phase to receive either a single subcutaneous dose of short-acting insulin (n = 11) or a continuous intravenous

insulin infusion (n = 12) at a rate adjusted by glucose levels measured every 10 min and targeted to plasma glucose 4.5–6.0 mmol/l. Plasma glucose levels were significantly decreased with no serious adverse events in the intravenously treated group in comparison to a non-randomized control group (n = 38). The subcutaneous insulin administration did not achieve significant lowering of plasma glucose.

A systematic review showed that the in-hospital administration of intravenous insulin with the objective of maintaining serum glucose within a specific range in the first hours of acute ischaemic stroke does not provide benefit in terms of functional outcome, death or improvement in final neurological deficit, and significantly increased the number of hypoglycaemic episodes [21]. Specifically, the people whose glucose levels were maintained within a tighter range with intravenous insulin experienced a greater risk of symptomatic and asymptomatic hypoglycaemia than the people in the control group. The situation may therefore be even more risky in the pre-hospital phase.

Recommendation

Because of safety concerns pre-hospital administration of insulin in persons with suspected stroke and hyperglycaemia is not recommended.

(weak; very low quality of evidence)

PICO 7. In people with suspected acute stroke, does pre-hospital lowering of elevated body temperature compared to no intervention on body temperature improve outcome?

Data on 5305 patients from the Virtual International Stroke Trials Archive data set showed that delayed hyperthermia was more strongly associated with poor outcome than elevated body temperature seen in the hours after stroke [22]. A prospective study of 725 patients also found that initial elevated body temperature in hyperacute ischaemic stroke was not associated with worse outcome, but a rise in body temperature in severe strokes was related to poor outcome. It was concluded that elevated body temperature within 6 h of stroke onset had no prognostic influence on stroke outcome at 3 months [23].

Antipyretic drugs and cooling methods can lower body temperature in stroke patients. However, no clinical studies have investigated pre-hospital treatment of elevated body temperature in acute stroke patients.

Recommendation

In the absence of clinical studies no recommendations can be made on pre-hospital interventions for lowering elevated body temperature.

Rapid care by a dedicated stroke team

PICO 8. In patients with suspected acute stroke, does implementation of pre-hospital 'code stroke' protocols compared to no implementation of such protocols reduce onset to admission time, door to needle time and frequency of thrombolysis?

The search revealed 43 citations, of which nine studies, including one RCT, were considered relevant. The RCT, performed in the Stockholm area, compared the effect of upgrading the priority level at the Emergency Medical Communication Centre (EMCC) from the standard level 2 (ambulance arrival at scene within 30 min unless no priority 1 alarms required that ambulance) to level 1 (immediate ambulance response) [24]. In the group randomized to level 1 there was a significantly shorter delay (13 min) from EMCC call to arrival at the hospital ($P < 0.001$) and a significant increase in thrombolysis frequency (24% vs. 10%; $P < 0.001$). The door to needle time was not significantly different as eligible patients from the control group were also prioritized at the emergency department.

Several observational studies have reported that pre-hospital notification of the receiving hospital without or with prioritized transport to designated hospitals with stroke expertise (bypassing the nearest hospitals) led to significantly shorter door to needle time or door to brain imaging time [25–32] and higher rates of intravenous thrombolysis [25,26,28–31]. Most studies compared findings either with findings from a historical control group (six) or with findings from a parallel observation of patients for whom no pre-notification intervention was used (two). In most studies improved pre-hospital management was also associated with improved in-hospital reorganization, indicating that pre-hospital 'code stroke' and in-hospital 'code stroke' are a continuum aimed at shortening onset to treatment time. A meta-analysis of these observational studies is not feasible because of different study designs and methodological approaches, and qualitative differences in regional EMS organization where the studies were performed. However, all studies consistently show that implementing a pre-hospital 'code stroke' protocol including priority EMS dispatch, rapid transport to the closest 'stroke ready' centre (bypassing nearest hospitals that are not 'stroke ready') and pre-arrival notification to the receiving hospital leads to faster times to treatment and higher treatment rates.

Recommendation

It is recommended that all EMS implement a 'code stroke' protocol, including highest priority dispatch,

pre-hospital notification and rapid transfer to the closest 'stroke-ready' centre.

(strong; moderate quality of evidence)

PICO 9. In people with suspected stroke does pre-hospital telemedicine, compared to no telemedicine, improve outcome?

Telemedicine with real-time bidirectional audio–video communication between the ambulance and a stroke physician may enable early assessment of a patient with suspected stroke and might thereby reduce in-hospital delays to receive relevant treatment. Thirty-six papers were identified. Pilot studies indicate that this approach is feasible [33,34]. No RCTs were found on whether pre-hospital telemedicine in acute stroke patients speeds up door to treatment time and improves outcome. Only one observational study compared door to imaging time in patients who received pre-hospital telemedicine (n = 16) versus controls (n = 42). No statistically significant difference was found between door to imaging time in patients who received pre-hospital telemedicine: median (interquartile range) 59.5 (67.5) min versus controls 57.5 (80) min, P = 0.65 [33].

Recommendation

No recommendation on the additional value of pre-hospital telemedicine can be made.

PICO 10. In patients with acute stroke, does the use of mobile emergency stroke units, compared to no use of such units, improve outcome?

Studies with mobile emergency stroke units, which are specialized ambulances staffed by a neurologist/physician or nurse, paramedic/emergency medical technician and radiology technician, and equipped with a CT scanner, point-of-care laboratory and telemedicine connection were searched for. Thrombolysis was administered at the scene in the mobile stroke unit. The search revealed three relevant studies: two RCTs [35,36] and one small observational study [37]. Studies were unblinded and specific to the local setting.

Grading of the quality of evidence was based on the two RCTs comparing mobile emergency stroke unit intervention with hospital intervention (Appendix S1, GRADE table). In the mobile emergency stroke unit group, rate of thrombolysis was increased [odds ratio (OR) 1.79; 95% confidence interval (CI) 1.44–2.33], with a median reduction in call to needle time of 24–34 min and a median reduction in onset to needle time of 24–81 min. No safety concerns have been raised. There was no increase in symptomatic intracranial haemorrhage (OR 0.59; 95% CI 0.25–1.38) in the mobile emergency stroke unit group. However, there were insufficient data about functional outcome to determine effectiveness. Only one study investigated 7-day outcome [35]. There was no significant difference between the mobile emergency stroke unit group and the control group in the number of patients who were independently defined as a modified Rankin Scale score <3. In the large PHANTOM-S trial [36], mean door to needle time in the control group receiving usual hospital care was 42 min, which could be further improved by reducing in-hospital delays. Two studies provided arguments in support of the cost-effectiveness of mobile emergency stroke units [38,39].

Recommendation

The routine use of mobile emergency stroke units is not recommended because there is insufficient evidence that they lead to better functional outcome.

(weak; low quality of evidence)

Additional comments

Although the influence of mobile emergency stroke units on the outcome of patients with stroke is uncertain, they can reduce onset to needle times for intravenous thrombolysis in patients with ischaemic stroke and can be an option for certain regions where traditional ambulance transport would result in significant delays.

PICO 11. In persons with suspected acute stroke, does the use of pre-hospital point-of-care (POC) laboratory analysis of blood count and international normalized ratio (INR), compared to no use of such means, speed up door to needle time in ischaemic stroke or interventions to prevent worsening of haemorrhagic stroke?

Determination of the platelet count and INR is important in patients taking vitamin K antagonists, with liver dysfunction, haemorrhagic diathesis or an unclear medication history. Observational studies reported that measuring these parameters by POC testing in the emergency department, instead of awaiting central laboratory results, reduced door to needle time [40,41]. No clinical trial has assessed whether pre-hospital POC analyses of INR and blood count have an additional effect in reducing door to needle time or improving management of haemorrhagic stroke.

Recommendation

No recommendation on the use of pre-hospital POC laboratory analysis of blood count and INR can be made.

PICO 12. In persons with suspected acute stroke, can biomarkers accurately differentiate between ischaemic stroke, haemorrhagic stroke or a stroke mimic?

A comprehensive systematic review using QUADAS criteria for assessing the quality of studies found that

no individual biomarker has adequate sensitivity and specificity for a clinically useful diagnostic test [42]. A number of studies have attempted a multi-marker panel approach in order to improve sensitivity and specificity. However, thus far none has been successful in a clinical setting. None of these studies was performed in a pre-hospital setting [42].

Recommendation
No recommendation can be made on the use of currently available biomarkers in persons with a suspected stroke.

PICO 13. In persons suspected of acute stroke, does air medical transport compared to ground transport improve outcome?
The search revealed 88 citations, of which only one observational study made an acceptable comparison to ground transport. This retrospective examination of the Austrian Stroke Unit Registry found that air transport was associated with greater thrombolysis activity compared to a standard ambulance (OR 3.36; 95% CI 2.8–4.0) and physician ambulance (OR 1.45; 95% CI 1.2–1.7), and a mean 30 min (95% CI 41–18) less onset to hospital arrival time compared to standard ambulance but not physician ambulance (5 min longer; 95% CI 1–9) [43]. However, there was no information regarding air transport availability or the criteria used to trigger its dispatch in preference to ground transport when it was available.

Recommendation
Air medical transport is not suggested outside of settings where a pragmatic decision has been taken that geographical conditions favour air transport.

(weak; very low quality of evidence)

PICO 14. In acute stroke patients do pre-hospital neuroprotective therapies improve outcome?
Three RCTs of neuroprotective therapies initiated before hospital admission were identified.

The first study was a randomized, controlled, double blind, placebo controlled study of oral nimodipine 30 mg every 6 h for 10 days in patients in whom treatment could be initiated within 6 h of stroke onset [44]. There was no significant difference between the nimodipine group and the placebo group on the primary outcome, which was defined as death or dependency at 3 months.

The second study was a randomized, placebo controlled double blind study of intravenous infusion of magnesium sulfate started in the ambulance in both ischaemic and haemorrhagic stroke [45]. The study included all stroke patients in whom treatment could be initiated up to 2 h after symptom onset. Active treatment did not decrease the risk of being dead or dependent 90 days after the stroke.

The third study was a placebo controlled, open label study of remote ischaemic preconditioning for ischaemic stroke [46]. The primary end-point was penumbral salvage, defined as the volume of the perfusion–diffusion mismatch not progressing to infarction after 1 month. The trial failed to show a difference between patients receiving remote ischaemic preconditioning and not.

Recommendation
The use of any neuroprotective intervention in persons with suspected acute stroke was not recommended in the pre-hospital setting.

(strong; high quality of evidence)

Discussion

A serious limitation of this guideline is the paucity of RCTs available on pre-hospital management of stroke. The GRADE system only allows grading of the strength of recommendation as strong or weak. This on the one hand allows a clear statement on a specific PICO question, but on the other hand does not allow an intermediate recommendation in cases assumed to have insufficient data. For a number of PICO questions no recommendation could be given because of insufficient data. Based on consensus a strong recommendation was given for some PICO questions for which no RCTs were available, e.g. when observational studies consistently showed a similar effect, or if the panel found that desirable consequences outweigh undesirable consequences, or if most or all patients would be best served by a particular management strategy.

Despite low quality of evidence public educational campaigns to increase public awareness of immediately calling EMS for persons with suspected acute stroke is strongly supported. Studies were very heterogeneous, and the potential clinical benefit of public campaigns may be difficult to identify in a short-term follow-up. Further studies are required to find out which methods are most effective in successfully educating the general public about the urgency of stroke.

Moderate quality of evidence was found to strongly support the training of EMS personnel in recognizing the symptoms of stroke using simple stroke scales, such as the FAST or LAPSS. No recommendation can be given for a specific stroke scale.

Moderate quality of evidence was found to strongly support implementing a pre-hospital 'code stroke' system by the EMS, which includes highest priority ambulance dispatch, prioritized transport to the closest 'stroke-ready' centre and pre-notification of the receiving hospital. When possible, EMS should bypass hospitals that are not ready to deliver appropriate acute stroke treatment immediately. Pre-notification allows the stroke team to get ready before the patient actually arrives at the hospital.

Further studies are required to investigate whether pre-hospital stroke scales predicting large vessel occlusion might be used as a triaging tool to select stroke patients for direct transport to comprehensive stroke centres capable of endovascular interventions.

Very low quality of evidence is available for pre-hospital management of physiological parameters, such as treatment of hypoxia, management of blood pressure and hyperthermia. Nevertheless, maintaining normoxia is strongly recommended, and the use of blood pressure lowering medication and of insulin in persons with suspected stroke and hyperglycaemia is not recommended unless in cases of extreme urgency.

Preliminary studies using bidirectional audiovisual telemedicine during ambulance transport show that this method is feasible and may provide valuable information to the hospital stroke team. However, such intervention should not cause any delay in the pre-hospital stroke care pathways, and its additional value on top of existing pre-hospital 'code stroke' systems, including systematic pre-notification of the receiving hospital, will have to be supported by RCTs. Despite recent studies reporting the feasibility of mobile emergency stroke units in delivering intravenous thrombolysis at the scene, there is currently no evidence that this costly intervention improves outcome. Mobile stroke units allowing CT angiography could be useful for the early identification of patients with large artery occlusion.

No evidence was found for the pre-hospital use of laboratory biomarkers in diagnosing stroke, POC laboratory analysis for blood count and INR, and neuroprotective therapies.

Disclosure of conflicts of interest

GAF developed the FAST and ROSIER scales and was chief investigator of the PILFAST study. JDK is involved in pre-hospital telemedicine studies.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. PICO 10. Should mobile stroke units be used for thrombolysis of acute ischaemic stroke?

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